PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B65B 43/50, B65G 47/84 — A1

(11) International Publication Number: **WO 96/26114**

(43) International Publication Date: 29 August 1996 (29.08.96)

(21) International Application Number: PCT/GB96/00357

(22) International Filing Date: 16 February 1996 (16.02.96)

(30) Priority Data:
9503277.7 20 February 1995 (20.02.95) GB

(71) Applicant *(for all designated States except US)*: TETRA LAVAL HOLDINGS & FINANCE S.A. [CH/CH]; 70, avenue Général-Guisan, CH-1009 Pully (CH).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: MOSSE, Richard, Wolfgang, Emil [GB/GB]; 28 Clifton Hill, London NW8 0QG (GB). MOSSE, Charles, Alexander [GB/GB]; 21 Parliament Hill, London NW3 2TA (GB). CHAI, Huazhen [CN/GB]; 12 Westmoor Gardens, Enfield, Middlesex EN3 7LO (GB).

(74) Agent: SMART, Peter, J.; W.H. Beck, Greener & Co., 7 Stone Buildings, Lincoln's Inn, London WC2A 3SZ (GB).

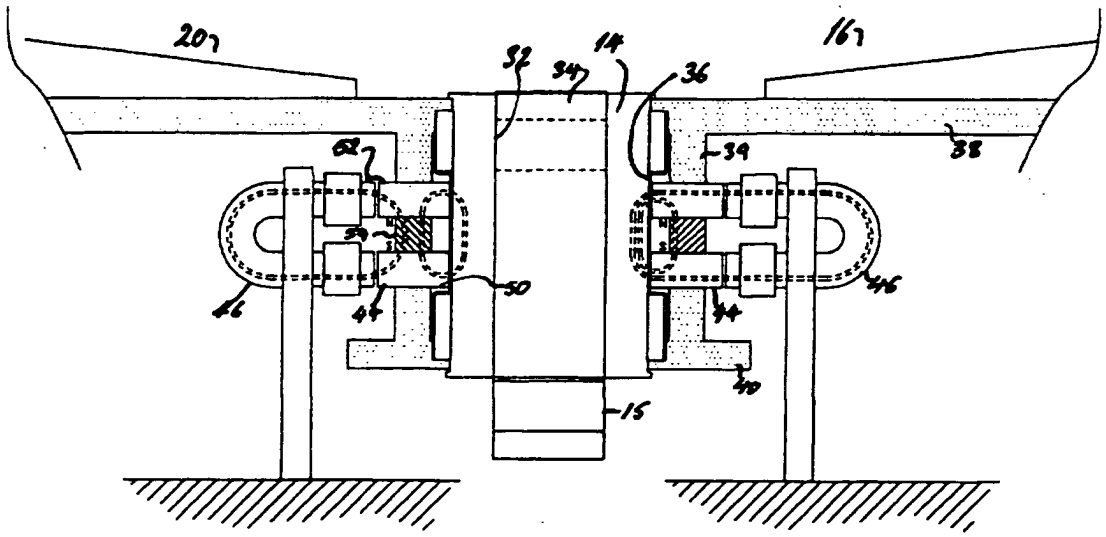
(81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published

With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: METHODS AND APPARATUS FOR CONVEYING OBJECTS



(57) Abstract

Objects (14) such as transport holders containing carton blanks are transferred between first and second conveyors (16, 20). The objects are held on the first conveyor prior to transfer and on the second conveyor after transfer by travelling magnets (44). At the instant of transfer, the attraction of the travelling magnet of the first conveyor is weakened by interaction with a fixed magnet (46) which diverts magnetic flux from the object (14), and simultaneously, the attraction of the travelling magnet of the second conveyor is boosted by interaction with a fixed magnet (46) which reinforces the flux path through the object (14). The precision of the timing of the transfer is thereby improved and is made readily adjustable by repositioning of the fixed magnets (46).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	**GB**	United Kingdom	**MW**	Malawi
AT	Austria	**GE**	Georgia	**MX**	Mexico
AU	Australia	**GN**	Guinea	**NE**	Niger
BB	Barbados	**GR**	Greece	**NL**	Netherlands
BE	Belgium	**HU**	Hungary	**NO**	Norway
BF	Burkina Faso	**IE**	Ireland	**NZ**	New Zealand
BG	Bulgaria	**IT**	Italy	**PL**	Poland
BJ	Benin	**JP**	Japan	**PT**	Portugal
BR	Brazil	**KE**	Kenya	**RO**	Romania
BY	Belarus	**KG**	Kyrgystan	**RU**	Russian Federation
CA	Canada	**KP**	Democratic People's Republic of Korea	**SD**	Sudan
CF	Central African Republic			**SE**	Sweden
CG	Congo	**KR**	Republic of Korea	**SG**	Singapore
CH	Switzerland	**KZ**	Kazakhstan	**SI**	Slovenia
CI	Côte d'Ivoire	**LI**	Liechtenstein	**SK**	Slovakia
CM	Cameroon	**LK**	Sri Lanka	**SN**	Senegal
CN	China	**LR**	Liberia	**SZ**	Swaziland
CS	Czechoslovakia	**LT**	Lithuania	**TD**	Chad
CZ	Czech Republic	**LU**	Luxembourg	**TG**	Togo
DE	Germany	**LV**	Latvia	**TJ**	Tajikistan
DK	Denmark	**MC**	Monaco	**TT**	Trinidad and Tobago
EE	Estonia	**MD**	Republic of Moldova	**UA**	Ukraine
ES	Spain	**MG**	Madagascar	**UG**	Uganda
FI	Finland	**ML**	Mali	**US**	United States of America
FR	France	**MN**	Mongolia	**UZ**	Uzbekistan
GA	Gabon	**MR**	Mauritania	**VN**	Viet Nam

METHODS AND APPARATUS FOR CONVEYING OBJECTS

The present invention relates to methods for transferring objects between conveyors by magnetic attraction and to apparatus for conveying objects in which such transfers take place. The invention includes packing apparatus in which containers are filled and closed, with separate such operations being conducted on respective conveyors between which the containers are transferred by such methods.

In our Patent Co-operation treaty application WO95/02539 there is described a packing machine in which there are a series of wheel conveyors on which holders for packing containers such as cartons are transported around a closed path, being passed from conveyor to conveyor in transfer operations. Carton blanks are loaded into the transport holders, bottom closed, filled, top closed and discharged, each operation being conducted as the transport holders are carried on a respective wheel conveyor. The transport holders are held on each wheel conveyor by radially acting magnets located at the base of recesses in the periphery of each wheel conveyor. In each transfer operation, a transport holder is brought by wheel rotation to lie simultaneously in recesses of two adjacent wheel conveyors and as the wheel conveyors rotate further the transport holder is caused to transfer from one wheel conveyor to the other where it is again held by magnetic attraction. The magnets are all of similar strength and biassing means of various kinds are described for triggering transfer of the transport holders between conveyors. The biassing means can be a fixed magnet located at the site of the transfer operation and arranged to attract the transport holders to the downstream one of the wheel conveyors. It can be means serving to withdraw the magnet holding the transport holder on the more upstream conveyor so that its attraction for the transport holder is weakened.

Whilst such biassing methods can be used successfully, there is a problem in achieving sufficiently precise timing

of the transfer of the transport holder. It is highly desirable that the balance of magnetic forces switches positively between the two conveyors at exactly the instant that the transport holder is fully in the recesses of both conveyors simultaneously, otherwise there is an irregularity in the serpentine motion of the transport holders through the apparatus with the transport holders to some extent jumping across a gap between successive conveyors. This may cause splashing of liquid contents filled into the containers, excessive noise and wear, and rotational misalignment of the cartons. The withdrawal of one of the magnets by the action of a cam prevents this but requires precise machining of the cam track used and offers little facility of adjustment.

The present invention provides a method of transferring an object (14) from a first conveyor (16) to a second conveyor (20) in a transfer operation in which the object is carried on said first conveyor, is brought to said first conveyor into close proximity to said second conveyor, and is transferred thereto, wherein:

a) the object is held on said first conveyor by attraction to a magnet travelling therewith, and to produce said transfer, the magnetic attraction between the object and the first conveyor is decreased by one or more flux path providers which alter the magnetic field of the travelling magnet of the first conveyor to reduce the attraction of the travelling magnet of the first conveyor; and/or

b) after said transfer the object is held on the second conveyor by attraction to a magnet travelling therewith, and to produce said transfer, and magnetic attraction between the object and the second conveyor is increased by one or more flux path providers which alter the magnetic field of the travelling magnet of the second

conveyor to increase the attraction of the travelling magnet of the second conveyor.

In a preferred aspect the invention provides a method of transferring an object from a first conveyor to a second conveyor in a transfer operation in which the object is held on said first conveyor by attraction to a magnet travelling therewith, is brought on said first conveyor into close proximity to said second conveyor, is transferred thereto, and is held thereon by attraction to a magnet travelling with the second conveyor, wherein to produce said transfer, the magnetic attraction between the object and the first conveyor is decreased and/or the magnetic attraction between the object and the second conveyor is boosted by one or more magnetic flux path providers which alter the magnetic field of the travelling magnet of one or both of said conveyors to increase the attraction of the travelling magnet of the second conveyor and/or reduce the attraction of the travelling magnet of the first conveyor.

Whilst it is preferred that the object is held on each of the first conveyor and the second conveyor magnetically by respective travelling magnets, this is not essential. Either of the two conveyors may carry the object by means other than magnetic attraction.

Preferably, said travelling magnets are permanent magnets. The use of travelling electromagnets is permissible but generally involves unnecessary complexity.

Said magnetic flux path provider or providers may be magnets or they may be passive bodies which are good conductors of magnetic flux, e.g. iron or steel. Where magnets are used they also may be permanent magnets. When passive flux path providers or permanent magnets are used these are preferably stationary in the sense of occupying a constant position during the transfer operation, although their precise position is preferably adjustable.

Preferably then, the or each flux path provider is a magnet, which may be a stationary, permanent magnet, serving to alter the field of a travelling magnet. Whereas in WO95/02539 where stationary magnets were used to bias the transfer, they acted directly on the object to be transferred, here they are used to act on the travelling magnets to alter the attraction thereof for the object.

Preferably, at least one of said travelling magnets at the time of the transfer has a first flux path from the north pole thereof via said object to the south pole thereof and an alternative flux path from the north pole thereof via a said field altering magnet to the south pole of said travelling magnet, such that a said field altering magnet reinforces said first flux path of the travelling magnet of the second conveyor and/or deflects flux of the travelling magnet of the first conveyor from said first path into said second path.

Said travelling magnet is preferably generally I shaped, having a pair of pole pieces extending transversely of and connected by a magnetic web portion, said pole pieces each having a first end for attracting said object and each having a portion extending from said web to a second, opposite end, and during said transfer respective poles of a said field altering magnet are arranged adjacent said portions of the pole pieces of the travelling magnet.

Said field altering magnet or magnets may be electromagnets. They may be supplied with a constant voltage of constant polarity and operate exactly like the permanent field altering magnets described above but preferably they are activated and deactivated, by variations and reversals of voltage as described below. Thus, preferably, the magnetic attraction between the object and the travelling magnet of the first conveyor is decreased and/or the magnetic attraction between the object and the travelling magnet of the second conveyor is boosted by the activation of one or more such electromagnets which increase the attraction of the travelling

magnet of the second conveyor and/or reduce the attraction of the travelling magnet of the first conveyor.

The switching of the electrical current to activate the electromagnet or electromagnets can be precisely timed by mechanical or optical triggers and the timing can be adjusted without difficulty.

Preferably, the electromagnet or electromagnets is or are fixed in position adjacent the site of the transfer operation. However, it is permissible for the electromagnets to travel with the travelling magnets. Preferably, there is such an electromagnet arranged to alter the strength of the travelling magnet of the first conveyor and a second such electromagnet arranged to alter the strength of the travelling magnet of the second conveyor. At the desired instant of transfer therefore, the attraction of the travelling magnet of the upstream conveyor may be weakened and simultaneously the attraction of the travelling magnet of the downstream conveyor may be boosted.

Preferably therefore, the polarity of each electromagnet is reversed at the desired instant of transfer. Preferably, the reversal of the polarity is accompanied by the application to each electromagnet of a transient voltage spike of the new polarity to ensure rapid reversal of the field. The transient voltage applied may be from 10 to 100 times the voltage constantly applied to the electromagnetic and may have a duration of from 0.1 to 100 ms.

Preferably, at least one of said travelling magnets has a first flux path from the north pole thereof via said object to the south pole thereof and an alternative flux path from the north pole thereof via a said electromagnet to the south pole of said travelling magnet, such that activation of said electromagnet in a first polarity reinforces said first flux path and activation of said electromagnet in an opposite polarity deflects flux from said first path into said second path.

The required flux paths are readily provided if said travelling magnet is generally I shaped, having a pair of pole pieces extending transversely of and connected by a magnetic web portion, said pole pieces each having a first end for attracting said object and each having a portion extending from said web to a second, opposite end, and wherein respective poles of said electromagnet are arranged adjacent said portions of the pole pieces of the travelling magnet.

The method of transferring objects according to the invention may be applied to apparatus of the general kind described above and accordingly it is preferred that said first conveyor and said second conveyor each have a location or a plurality of spaced locations for carrying said object or respective said objects, and said object when held in said location of the first conveyor follows a path which runs tangential to and in the same direction as a portion of a path followed by said second conveyor, such that during said transfer operation the object is momentarily simultaneously in the or a carrying location of the first conveyor and in the carrying location of the second conveyor to which the object is transferred.

Preferably, said carrying locations of said first and second conveyors move around a closed path and each carrying location comprises a radially outward facing recess for receiving one side of a said object, said travelling magnets each being positioned at a said recess to attract a said side of a said object in said recess.

The recesses and the objects are preferably so shaped that when a said object is simultaneously received in a pair of recesses of the first and second conveyors, the object is rotatable within each said recess about a respective axis transverse to the plane in which the object is being conveyed and each said recess has a surface engaging the object received therein which in cross-section transverse to said axis of rotatability defines a part circle.

The power of attraction of each travelling magnet for the object is preferably substantially equal.

The method of producing transfer described above may be applied to a method of conveying objects in a closed path defined by a plurality of conveyors between which the objects are transferred in respective transfer operations, each conveyor having a location or a plurality of locations for carrying such objects, and each said location having a said travelling magnet as means for holding a said object in said location, wherein in each transfer operation between a more upstream conveyor and a subsequent conveyor each said object is held in a said location on said more upstream conveyor and follows a path which runs tangential to and in the same direction as a portion of a path followed by a said location on said subsequent conveyor, and during each said transfer operation the respective object is momentarily simultaneously in a carrying location of the said conveyor and in a carrying location of the subsequent conveyor to which the object is transferred.

The methods of transfer described may also be used in a method of packing materials in containers comprising transporting containers on a first conveyor in transport holders, eg. transporting cartons in transport holders adapted to support the side walls of said cartons, subjecting the containers to filling, transferring the containers in their transport holders to a second conveyor by a method as described and closing the container tops as the containers are carried on the second conveyor to form closed filled containers and removing the containers from said transport holders. Further treatment steps may be carried out on other respective conveyors with similar transfers occurring between each conveyor. Such additional treatment steps may include cleaning and/or sterilisation, bottom closure of carton blanks, and folding of carton end seals.

The invention includes apparatus for conveying an object along a path, comprising a first conveyor and a second conveyor, each said conveyor defining a respective, adjoining portion of said path, said first and/or said second conveyor comprising a travelling magnet for holding a said object on a respective one of said conveyors, and means for producing transfer of said object from said first conveyor to said second conveyor, which means comprises one or more magnetic flux path providers which at the moment of transfer increase the attraction of a said travelling magnet of the second conveyor and/or reduce the attraction of a said travelling magnet of the first conveyor.

Such apparatus may have any or all the preferred features described above in connection with methods of the invention and may be embodied in apparatus for conveying objects comprising a first conveyor for carrying said objects, a second conveyor for carrying said objects once transferred thereto in respective transfer operations from said first conveyor, said first conveyor and said second conveyor each having a location or a plurality of spaced locations for carrying such objects and each said location having a said travelling magnet as means for holding a said object in said location, each said location preferably comprising a radially outwardly facing recess for receiving one side of a said object and having a said magnet acting radially for holding a said object by its side in said location, the conveyors being arranged such that each said object when held in a said location on the first conveyor follows a path which runs tangential to and in the same direction as a portion of a path followed by the second conveyor, and one or more said magnetic flux path providers, preferably field altering magnets, as means for causing each object in turn to transfer from the first conveyor to the second conveyor holding means on passing through said transfer operation, wherein during transfer the respective object is momentarily simultaneously in a carrying

location of said first conveyor and in a carrying location of said second conveyor to which the said object is transferred.

Apparatus according to the invention as described above may also be incorporated in apparatus for conveying objects in a closed path defined by a plurality of conveyors between which said objects are transferred in use in respective transfer operations, wherein said conveyors each have a location or a plurality of spaced locations for carrying such objects, each said location having a said travelling magnet as means for holding a said object in said location, and wherein each said object when held in a said location on a more upstream conveyor follows a path which runs tangential to and in the same direction as a portion of a path followed by a said location on the subsequent conveyor and during each transfer operation the respective object is momentarily simultaneously in a carrying location of the more upstream conveyor and in a carrying location of said subsequent conveyor to which said object is being transferred, one or more said magnetic flux path providers, preferably field altering magnets, being provided to vary the respective strengths of the magnetic attraction of the magnet means of the more upstream conveyor and the subsequent conveyor whilst said object is simultaneously in said two carrying locations so as to trigger transfer of the object from the more upstream conveyor to the subsequent conveyor.

Apparatus according to the invention may be embodied in apparatus for packing materials in containers such as cartons, comprising a series of conveyors for carrying said containers in transport holders, which where the containers are cartons are preferably suitable to support the side walls of the cartons, means associated with each of a plurality of said conveyors for carrying out a respective treatment on said containers whilst being carried on said conveyor, said treatments preferably including at least filling and closing, said conveyors each having a location or a plurality of spaced locations for carrying such transport holders and each said

location having a said travelling magnet for holding a said transport holder in said location, the conveyors being arranged such that each said transport holder when held in a said location on an upstream conveyor follows a path which runs tangential to and in the same direction as a portion of a path followed by a subsequent conveyor in said series and during each said transfer operation the respective transport holder is momentarily simultaneously in a carrying location of said upstream conveyor and in a carrying location of said subsequent conveyor to which the said transport holder is transferred, one or more said magnetic flux path providers, preferably field altering magnets, being provided for causing each transport holder in turn to transfer from each upstream conveyor to the next subsequent conveyor holding means on passing through said transfer operation.

The invention will be further described and illustrated by the following description of a preferred embodiment thereof with reference to the accompanying drawings in which:

Figure 1 shows in schematic plan view apparatus according to the invention in which transport holders are loaded with carton blanks and transferred between conveyors as the carton blanks are filled and sealed;

Figure 2 shows the interaction between two conveyors carrying transfer holder in apparatus according to the invention as illustrated in Figure 1 and illustrates the transfer of a transport holder from one to the other of the conveyors;

Figure 3 is a side elevation of the parts of the two conveyors of Figure 2 involved in the transfer;

Figure 4 is a schematic side elevation of an alternative magnet arrangement at the instant of transfer, in which a passive flux conductor is used in place of the electromagnets of Figure 3: and

Figure 5 is a view similar to Figure 4 of a further alternative magnet arrangement in which fixed permanent magnets are used in place of the electromagnets of Figure 3.

As shown in Figure 1, flattened, tubular carton blanks 15 are held in a magazine 10 and are erected into open tubular form and loaded on to a sixteen station first conveyor wheel 12 on which transport holders 14 are travelling or are loaded on to wheel 12 and are erected as they travel on it in their transport holders. The blanks are transferred in a first transfer operation of the kind described above on to a sixteen station sealing conveyor wheel 16, equipped with sixteen bottom closure forming units 18 (one shown) which rotate with the wheel.

The blanks are transferred as described to a filling conveyor wheel 20 of thirty stations equipped with thirty rotating filling heads 22 (one shown).

From here the filled, bottom sealed cartons are transferred as described on to twenty-five station wheel 24, at which no operation is carried out on the cartons.

They are again transferred as described to a top seal wheel 26 of sixteen stations having sixteen co-rotating top seal units 28 (one shown).

The filled and sealed cartons are transferred as described to a last wheel 30 from which they are unloaded downwards from their transport holders on to a conveyor on which they are removed for further handling. The transport holders 14, now empty, are transferred as described back on to conveyor wheel 12 to be reloaded.

The number of stations on each wheel may be selected to provide a desired journey time on the wheel to allow each particular task to be accomplished. An alternative preferred number of stations for the six wheels shown is 20, 20, 30, 20, 20, 12 starting at wheel 12 and ending at wheel 30.

All of the conveyor wheels are driven via intermeshed respective gear wheels sharing a common drive so that synchrony of movement of the conveyor wheels is guaranteed. The number of stations on each wheel is selected so that each carton will have sufficient time on that particular wheel to

undergo the particular process to which it is subjected, filling being the longest of the processes.

Apparatus of this general type is described in WO95/02539.

Each transport holder 14 for use in accordance with the invention may comprise a shell 34 which may suitably be of plastics or of metal, e.g. of aluminium alloy. Such a shell may have a generally circular transverse cross-section and may define a rectangular cross-section channel 32 in which is held in use a conventional open-ended tubular, laminated paper board, carton blank 15. Cartons of plastics or plastics laminate sheet may also be employed e.g. injection moulded cartons. The carton blank protrudes from the top and bottom of the transport holder 14 as seen in Figure 3. Part circular cross-section channels may be provided at each corner of the rectangular channel 32 in the transport holder shell to avoid damage to the corners of the blank.

The shells may be modified in that they have many curved ends which are part circular in cross-section separated by parallel sides.

At each end or at diametrically opposed locations there is provided a bar 36 (Figure 3) contained within the body of the material of the shell 34. The bars 36 may be permanent magnets but preferably are passively magnetically attractable, e.g. may be of soft iron. If not intended to be a permanent magnet, then each bar should preferably be made of an attractable material which will not acquire a permanent magnetic field of any substance when placed in contact with a permanent magnet.

The bar 36 need not be in the form of a bar but can be in the form of one or more pieces of any desired shape. It need not be contained within the body of the shell 34 but can be mounted on its surface.

By virtue of the use of the transport holders which provide support for the side walls of the cartons, the cartons may be moved through the apparatus at a speed which is

substantially greater than that achievable on current carton packing lines, e.g. at 200 to 400 cartons per minute or more. Furthermore, because of the non-stop cursive motion of the cartons through the apparatus, these higher speeds will not result in excessive splashing of liquid contents. Auxiliary apparatus used to perform operations on the carton blanks to form them into filled cartons such as devices for folding and sealing the bottom and top closures and devices for filling contents into the open topped cartons can be provided to rotate with their respective conveyors and can be powered in a known manner by electrical contact through slip rings.

The principle of the preferred method of transfer of the transport holders between successive conveyors is illustrated in Figures 2 and 3 in which a transport holder 14 is seen being passed between by way of example conveyors 16 and 20. Each of conveyors 16 and 20 comprises an upper wheel plate, a rim 39 depending from the edge of plate 38, and at its lower end bearing a flange 40 (see Figure 3) spaced from, parallel to and concentric with the upper wheel plate 38. Each conveyor has a plurality of recesses 42 about each wheel portion periphery, the circumferential spacing between recesses 42 being equal on each conveyor. Each conveyor is provided in each recess 42 with a single permanent travelling magnet 44 mounted in a respective window in rim 39 which interacts with the metal bar 36 at one side of the transport holder 14 to hold the transport holder on the conveyor. The curved side of each transport holder 14 is a conforming fit with a respective curved recess 42 in the conveyor. The permanent magnets 44 of conveyor 20 are of approximately the same strength as the magnets 44 of conveyor 16. A fixed electro-magnet 46 is provided on a support shelf 48 level with the windows of the rim 39 adjacent the path swept by magnets 44 in the nip between the conveyors. As each transport holder 14 is brought into the nip between the conveyors 16 and 20, the metal bar 36 at the free side of the transport holder 14 carried on a magnet 44 is brought close to a magnet 44 of

conveyor 20 as a touching contact is established between the free curved end of the transport holder 14 and the recess 42 of the conveyor 20. Each electromagnet 46 comprises a core of thin steel laminations and a field winding comprising two coils wired in parallel.

At the desired instant of transfer, the magnets 44 and 46 of the conveyor 16 come into line with one another with the magnet 46 lying immediately radially inward (behind) the magnet 44. At the same time, the magnets 46 and 44 of the conveyor 20 are similarly aligned. There is therefore competition between the magnets of the two conveyors to keep hold of the transport holder 14 as further rotation carries the transport holder out of the nip between the two conveyors.

Permanent magnet 44 comprises a pair of pole pieces 50, 52 connected by a permanently magnetic bridge portion 54. The pole pieces are preferably made of thin steel laminations similar to those used in the core of a transformer in order to minimise eddy currents and to allow a rapid change of flux. The electromagnets 46 are U-shaped with the free ends of the U aligned with ends of the pole pieces 50, 52 of magnet 44.

As magnet 44 bearing the transport holder 14 is brought by rotation into the position in Figures 2 and 3, the electro-magnet 46 of conveyor 16 is subjected to a current such that a south pole is produced in the electromagnet adjacent the south pole end of the permanent magnet 44. The flux of the permanent magnet 44 is thereby directed along a path which extends from the north pole thereof via the transport holder bar 36 and back to the south pole of the magnet 44. The electromagnet 46 of the conveyor 20 is either not provided with current at this stage or is activated by current flowing in the opposite direction to produce the situation shown in Figure 3 in which a north pole is produced adjacent the south pole of the permanent magnet 44 of the conveyor 20. This diverts the flux of the permanent magnet away from the bar 36 of the transport holder 14 and along a path through the electro-magnet. At the desired instant of transfer between

the conveyors, the polarity of the electro-magnets 46 is reversed so that the flux paths shown in Figure 3 are interchanged. The attraction of the permanent magnet 44 of the conveyor 20 becomes much stronger than the attraction of the permanent magnet 44 of the conveyor 16. The current reversal may be accompanied by a large voltage spike so that the polarity of the magnets changes very rapidly. For instance, each electromagnet may normally be subjected to a relatively small current such as 6 amps DC produced by a voltage of 3 volts and at the instant of transfer a voltage spike of say 60 volts DC may be applied to each of the electromagnets as the polarity is reversed and this may be followed by reverting to the previous voltage level, whilst maintaining the changed polarity. The reversal in the balance of forces holding the transport holder 14 may thereby be accomplished within approximately 2 milliseconds. The switching of the electromagnets may be controlled in response to sensors detecting the presence of the transport holder at the desired location, e.g. optical sensors or micro-switches. The positioning of the sensors may readily be adjusted so as to vary the timing of the electro-magnetic switch-over or the timing may be varied by electronic means.

Using the apparatus and method described above, it will not be a significant problem if the permanent magnets 44 are not precisely of the same strength as any differences will be swamped by the effect of the electromagnets. Prior to the transfer, one of the permanent magnets is strengthened by the effect of its electromagnet whilst the other is weakened so there will be no tendency for the transport holder to jump across the gap prematurely. The transfer between the magnets can be timed precisely to occur when the transport holder is in the exact nip between the two conveyors and is touching on each.

In the modification shown in Figure 4, the magnetic flux path providers constituted in Figure 3 by the two electromagnets 46 are replaced by a stationary field spoiler 446

constituted by a bar made up of thin steel laminations. When the travelling magnet 44 comes into alignment with spoiler 446, an alternative flux path is provided through the spoiler which competes with and diverts flux from the path through the transport holder shown on the left side of the figure. The holding power of the right hand magnet 44 is thereby weakened, producing the required transfer.

In Figure 5, the electromagnets 46 are replaced by permanent stationary magnets 546 of opposite polarities with respect to their adjacent travelling magnets. The magnet 546 of the upstream right hand conveyor is orientated to divert flux from the travelling magnet 44 into the magnet 546 and away from the transport holder, whilst the other magnet 546 on the downstream conveyor is orientated to reinforce the flux of its co-operating travelling magnet 44.

Whilst the arrangements shown in Figures 4 and 5 do not provide the same rapidity of flux diversion obtainable with the electromagnet arrangement of Figure 3, they offer advantages of simplicity, reliability and cheapness.

As hygienic cleaning or sterilisation of such machinery is likely to be of importance, the use of magnets as illustrated has particular advantages. The working faces of the conveyor wheel portions can be made smooth. The magnets can be covered by a material such as a layer of stainless steel or of plastics which will not detract too much from their attractive power leaving a surface which is easily cleanable.

Apparatus according to the invention may be provided with a plurality of transport holders having a channel of a first set of dimensions and a further plurality of transport holders having a channel of a different set of dimensions.

Although the invention has been described with reference to the illustrated preferred embodiments, many variations and modifications are possible within the scope of the invention.

CLAIMS

1. A method of transferring an object (14) from a first conveyor (16) to a second conveyor (20) in a transfer operation in which the object is carried on said first conveyor, is brought on said first conveyor into close proximity to said second conveyor, and is transferred thereto, wherein:

a) the object is held on said first conveyor by attraction to a magnet (44) travelling therewith, and to produce said transfer, the magnetic attraction between the object and the first conveyor is decreased by one or more flux path providers (46) which alter the magnetic field of the travelling magnet of the first conveyor to reduce the attraction of the travelling magnet of the first conveyor; and/or

b) after said transfer the object is held on the second conveyor by attraction to a magnet (44) travelling therewith, and to produce said transfer, the magnetic attraction between the object and the second conveyor is increased by one or more flux path providers (46) which alter the magnetic field of the travelling magnet of the second conveyor to increase the attraction of the travelling magnet of the second conveyor.

2. A method as claimed in Claim 1, wherein the object is held on said first conveyor prior to the transfer operation by attraction to a said travelling magnet and is held on said second conveyor after said transfer operation by a said travelling magnet.

3. A method as claimed in Claim 1 or Claim 2, wherein the or each said travelling magnet is a permanent magnet.

4. A method as claimed in any preceding claim, wherein the or each said magnetic flux path provider is a permanent magnet serving as a field altering magnet.

5. A method as claimed in Claim 4, wherein at least one of said travelling magnets at the time of the transfer has a first flux path from the north pole thereof via said object to the south pole thereof and an alternative flux path from the north pole thereof via a said field altering magnet to the south pole of said travelling magnet, such that a said field altering magnet reinforces said first flux path of the travelling magnet of the second conveyor and/or deflects flux of the travelling magnet of the first conveyor from said first path into said second path.

6. A method as claimed in Claim 5, wherein said travelling magnet is generally I shaped, having a pair of pole pieces (50, 52) extending transversely of and connected by a magnetic web portion (54), said pole pieces each having a first end for attracting said object and each having a portion extending from said web to a second, opposite end, and wherein during said transfer respective poles of a said field altering magnet are arranged adjacent said portions of the pole pieces of the travelling magnet.

7. A method as claimed in any one of Claims 1 to 3, wherein the or each said magnetic flux path provider is an electro-magnet.

8. A method as claimed in Claim 7, wherein said electromagnet or electromagnets are activated or deactivated at the desired instant of transfer to produce said field alteration.

9. A method as claimed in Claim 8, wherein at least one of said travelling magnets has a first flux path from the north pole thereof via said object to the south pole thereof and an alternative flux path from the north pole thereof via a said electromagnet to the south pole of said travelling magnet, such that activation of said electromagnet in a first polarity reinforces said first flux path and activation of said electromagnet in an opposite polarity deflects flux from said first path into said second path.

10. A method as claimed in Claim 9, wherein said travelling magnet is generally I shaped, having a pair of pole pieces (50, 52) extending transversely of and connected by a magnetic web portion (54), said pole pieces each having a first end for attracting said object and each having a portion extending from said web to a second, opposite end, and wherein respective poles of said electromagnet are arranged adjacent said portions of the pole pieces of the travelling magnet.

11. A method as claimed in any preceding claim, wherein said first conveyor and said second conveyor each have a location (42) or a plurality of spaced locations (42) for carrying said object or respective said objects, and said object when held in said location of the first conveyor follows a path which runs tangential to and in the same direction as a portion of a path followed by said second conveyor, such that during said transfer operation the object is momentarily simultaneously in the or a carrying location of the first conveyor and in the carrying location of the second conveyor to which the object is transferred.

12. A method as claimed in Claim 11, wherein said carrying locations of said first and second conveyors move around a closed path and each carrying location comprises a radially outward facing recess (42) for receiving one side of a said object, said travelling magnets each being positioned at a

said recess to attract a said side of a said object in said recess.

13. Apparatus for conveying an object (14) along a path, comprising a first conveyor (16) and a second conveyor (20), each said conveyor defining a respective, adjoining portion of said path, said first conveyor and/or said second conveyor comprising a travelling magnet (44) for holding a said object on a respective one of said conveyors, and means for producing transfer of said object from said first conveyor to said second conveyor, which means comprises one or more magnetic-flux path providers (46) which decrease the attraction of a said travelling magnet associated with the first conveyor and/or increase the attraction of a said travelling magnet associated with the second conveyor.

14. Apparatus as claimed in Claim 13, wherein each of the first and second conveyors comprises a said travelling magnet and a magnetic flux path provider is present for decreasing the attraction of said travelling magnet associated with the first conveyor and for increasing the attraction of said travelling magnet associated with the second conveyor.

15. Apparatus as claimed in Claim 13 or Claim 14, wherein the or each said travelling magnet is a permanent magnet.

16. Apparatus as claimed in any one of Claims 13 to 15, wherein the or each said magnetic flux path provider is a permanent magnet serving as a field altering magnet.

17. Apparatus as claimed in Claim 16, wherein at least one of said travelling magnets at the time of the transfer has a first flux path from the north pole thereof via said object to the south pole thereof and an alternative flux path from the north pole thereof via a said field altering magnet to the south pole of said travelling magnet, such that a said field

altering magnet reinforces said first flux path of the travelling magnet of the second conveyor and/or deflects flux of the travelling magnet of the first conveyor from said first path into said second path.

18. Apparatus as claimed in Claim 17, wherein said travelling magnet is generally I shaped, having a pair of pole pieces (50, 52) extending transversely of and connected by a magnetic web portion (54), said pole pieces each having a first end for attracting said object and each having a portion extending from said web to a second, opposite end, and wherein during said transfer respective poles of a said field altering magnet are arranged adjacent said portions of the pole pieces of the travelling magnet.

19. Apparatus as claimed in any one of Claims 13 to 15, wherein the or each said magnetic flux path provider is an electromagnet.

20. Apparatus as claimed in Claim 17, comprising means for activating or deactivating said electromagnet or electromagnets at the desired instant of transfer to produce said field alteration.

21. Apparatus as claimed in Claim 20, wherein at least one of said travelling magnets has a first flux path from the north pole thereof via said object to the south pole thereof and an alternative flux path from the north pole thereof via a said electromagnet to the south pole of said travelling magnet, such that activation of said electromagnet in a first polarity reinforces said first flux path and activation of said electromagnet in an opposite polarity deflects flux from said first path into said second path.

22. Apparatus as claimed in Claim 21, wherein said travelling magnet is generally I shaped, having a pair of pole pieces (50, 52) extending transversely of and connected by a magnetic web portion (54), said pole pieces each having a first end for attracting said object and each having a portion extending from said web to a second, opposite end, and wherein respective poles of said electromagnet are arranged adjacent said portions of the pole pieces of the travelling magnet.

23. Apparatus as claimed in any one of Claims 13 to 22, wherein said first conveyor and said second conveyor each have a location (42) or a plurality of spaced locations (42) for carrying said object or respective said objects, and said object when held in said location of the first conveyor follows a path which runs tangential to and in the same direction as a portion of a path followed by said second conveyor, such that during said transfer operation the object is momentarily simultaneously in the or a carrying location of the first conveyor and in the carrying location of the second conveyor to which the object is transferred.

24. Apparatus as claimed in Claim 23, wherein said carrying locations of said first and second conveyors move around a closed path and each carrying location comprises a radially outward facing recess (42) for receiving one side of a said object, said travelling magnets each being positioned at a said recess to attract a said side of a said object in said recess.

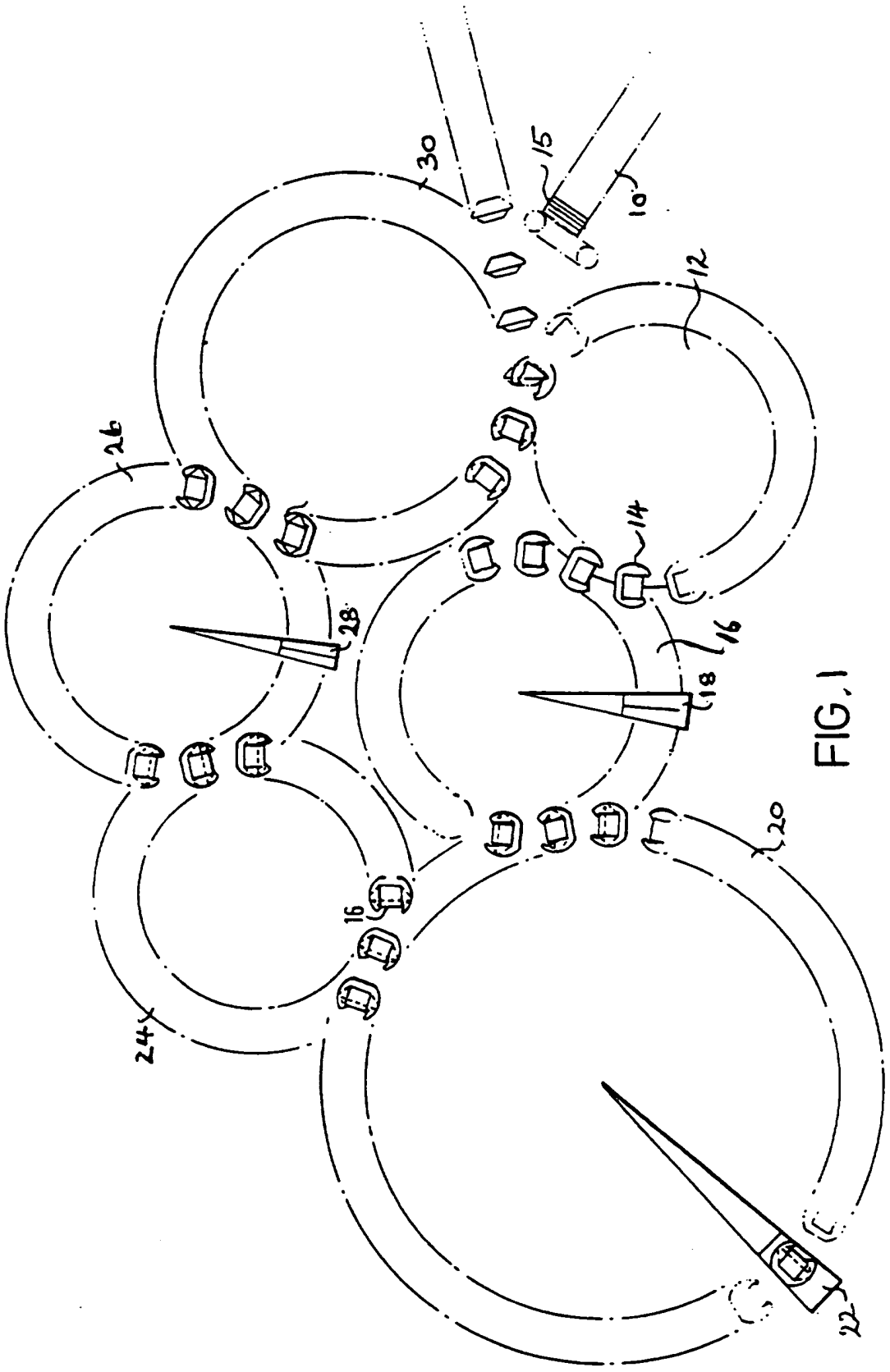


FIG. 1

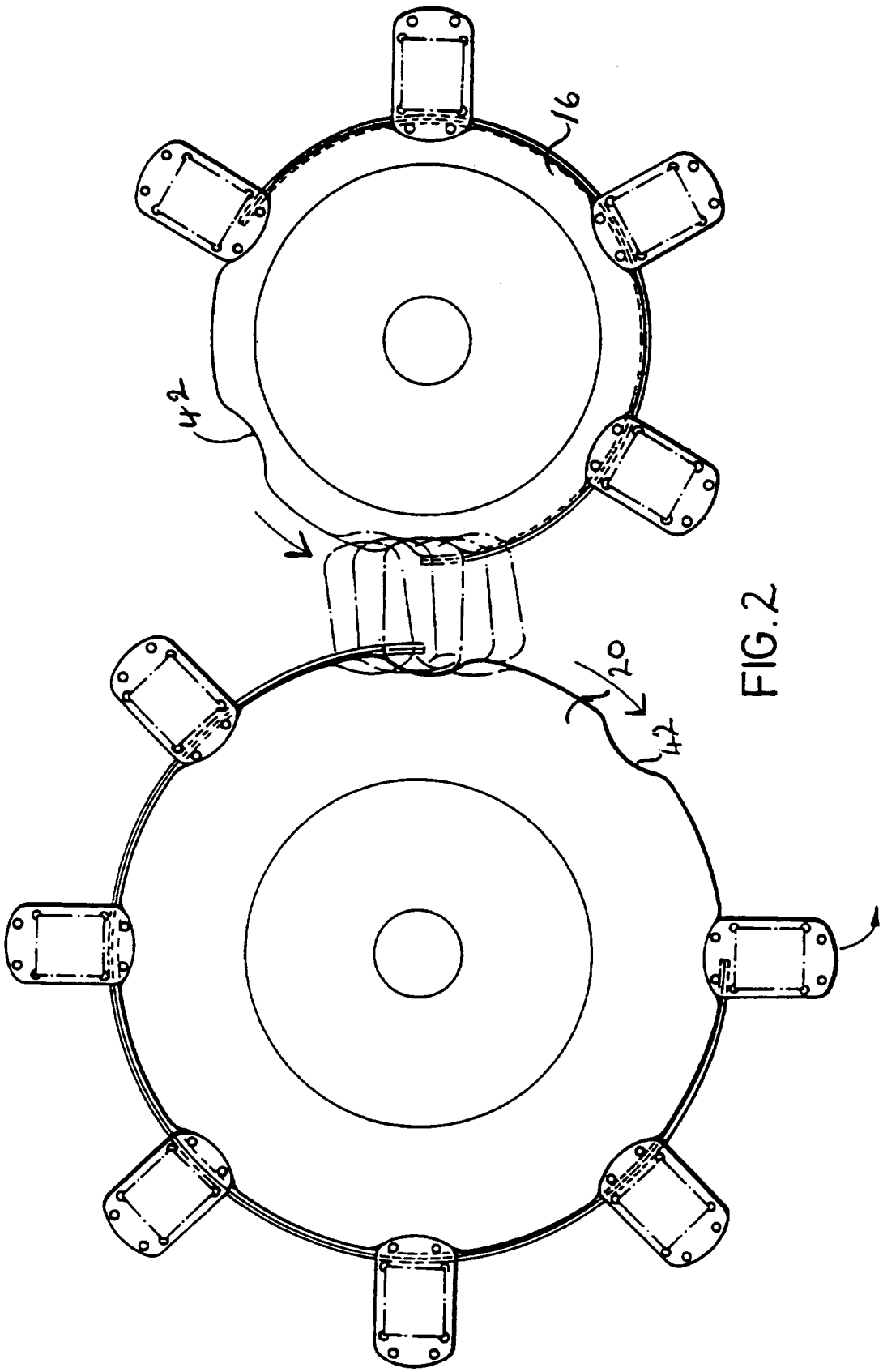


FIG. 2

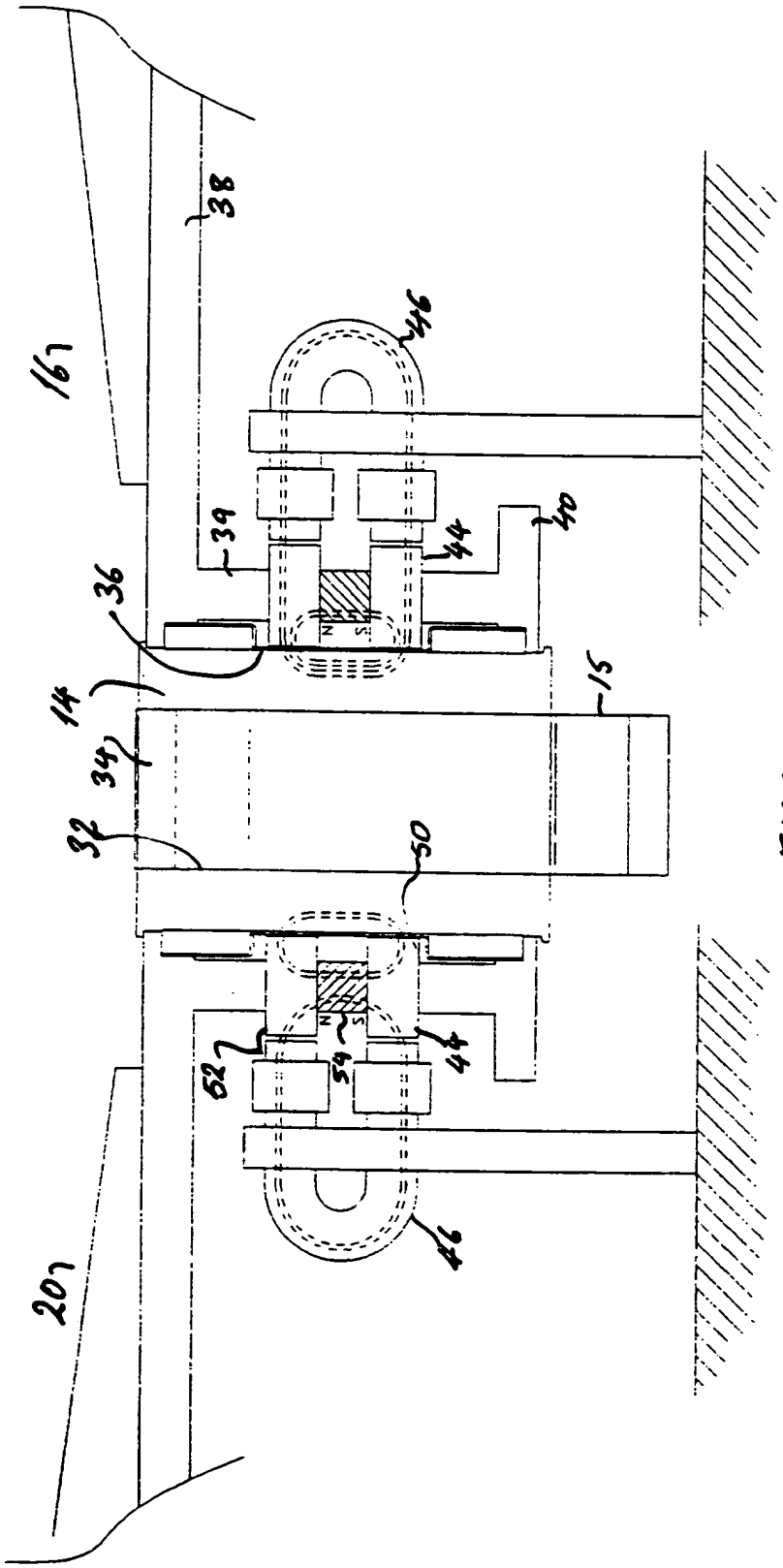


FIG 3

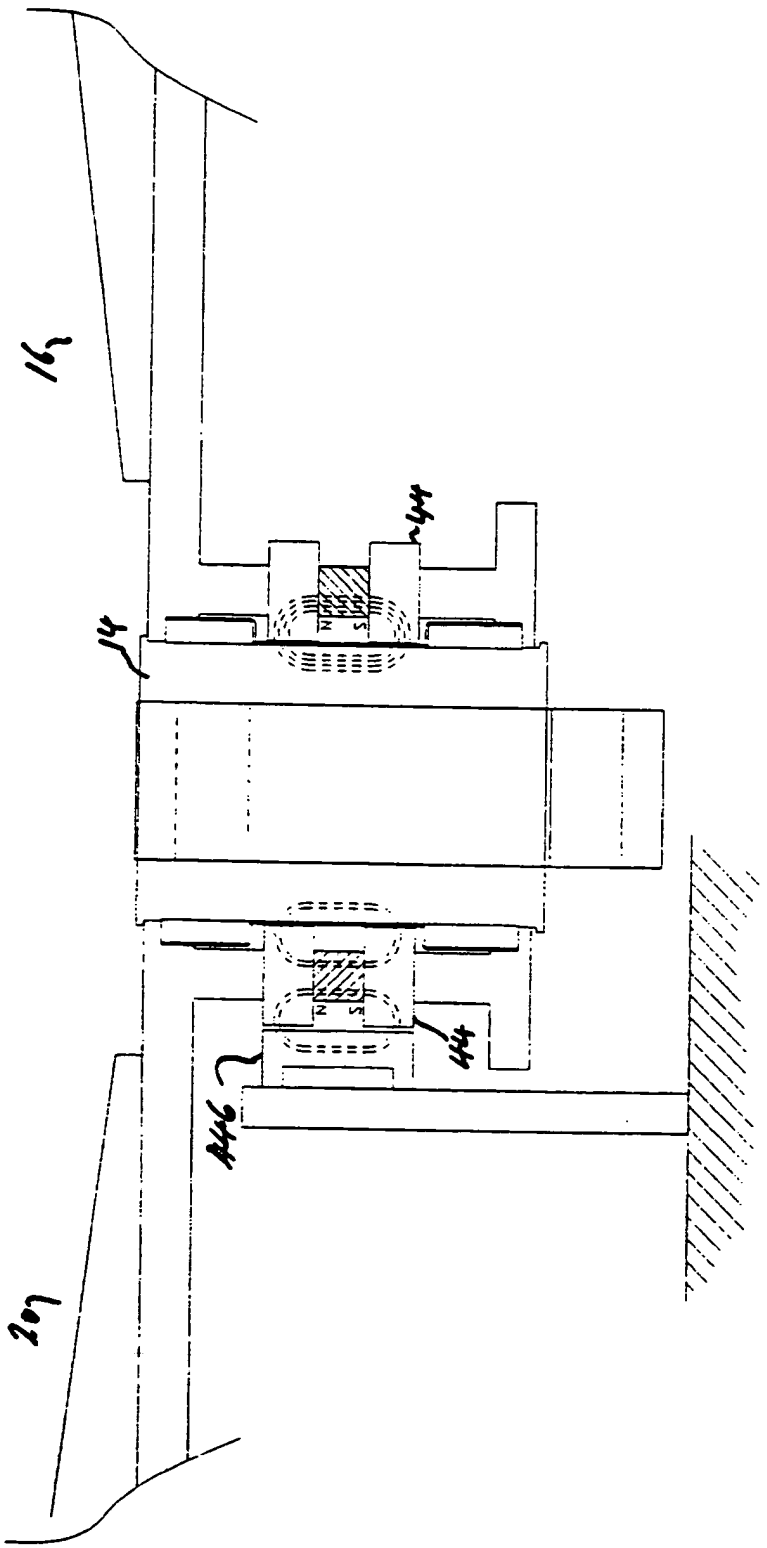


Fig 4

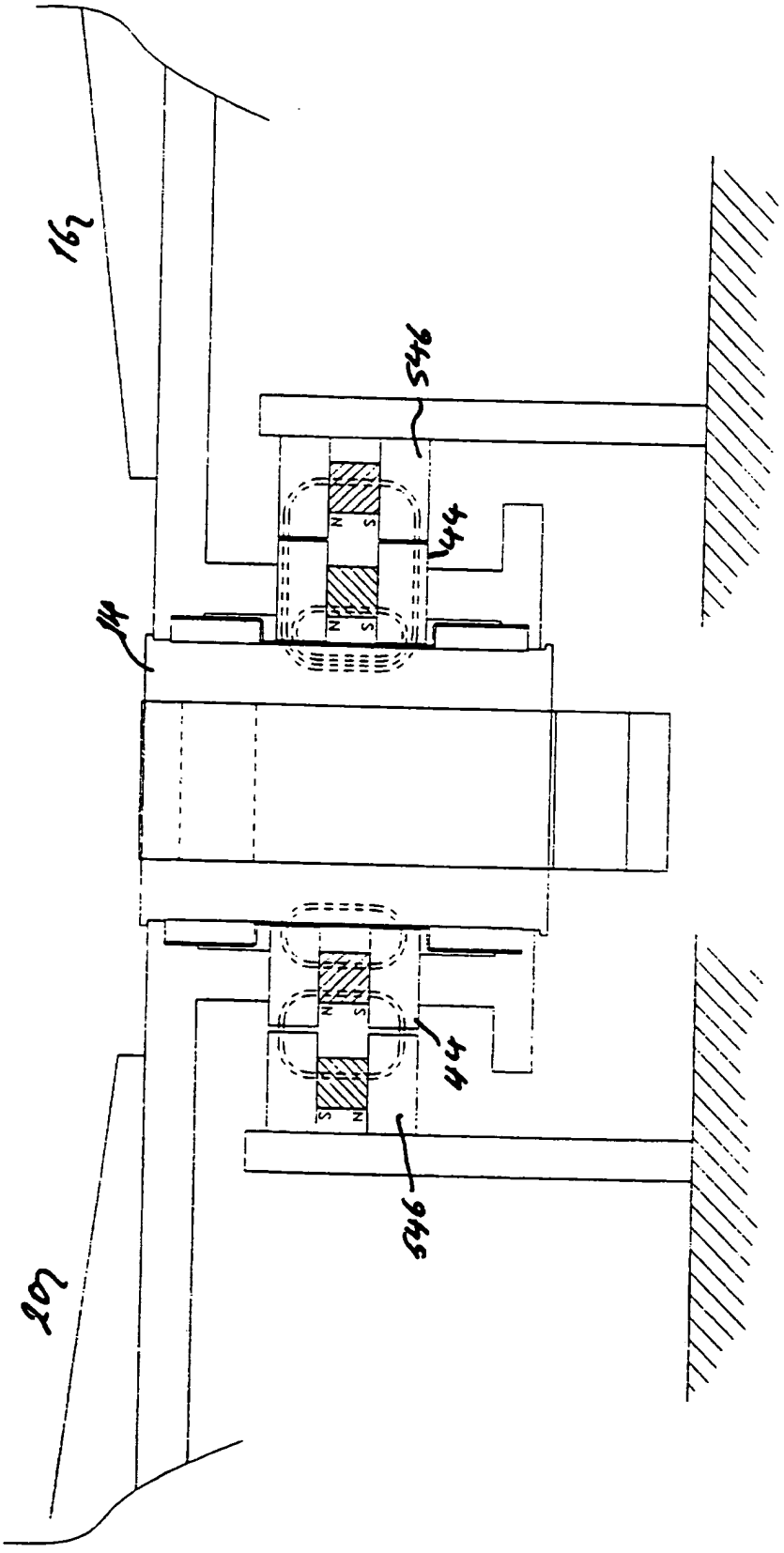


Fig 5

INTERNATIONAL SEARCH REPORT

Int onal Application No
PCT/GB 96/00357

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B65B43/50 B65G47/84

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B65B B65G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO,A,95 02539 (PAKCENTRE LTD.) 26 January 1995 cited in the application see page 10, line 27 - page 14, line 9; claims; figures	1-5,7,8, 11-16, 19,20, 23,24
X	EP,A,0 535 946 (KAO CORP.) 7 April 1993 see column 11, line 39 - column 12, line 31; figures 3,5,7	1-4, 13-15
A	EP,A,0 385 902 (ARMOR) 5 September 1990 see column 7, line 37 - column 8, line 25; claims; figures	1,13

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

2

Date of the actual completion of the international search
24 June 1996

Date of mailing of the international search report
28.06.96

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl,
Fax (+ 31-70) 340-3016

Authorized officer
Jagusiak, A

Form PCT/ISA/218 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int :onal Application No
PCT/GB 96/00357

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
WO-A-9502539	26-01-95	AU-B-	7130494	13-02-95
		CA-A-	2167285	26-01-95
		EP-A-	0707550	24-04-96
EP-A-535946	07-04-93	JP-A-	5092386	16-04-93
		JP-A-	5097186	20-04-93
		JP-A-	5092814	16-04-93
		US-A-	5509524	23-04-96
		US-A-	5337796	16-08-94
EP-A-385902	05-09-90	FR-A-	2643891	07-09-90
		US-A-	5020297	04-06-91